Vermicomposting

in your classroom

Reduce, Reuse, Recycle

CITY of SPRINGFIELD

SOLID WASTE MANAGEMENT DIVISION

♻ printed on recycled paper
revised 09/10

INTRODUCTION

The City of Springfield's Solid Waste Management Division presents this guide in order to provide classrooms with the knowledge and materials needed to develop and maintain a vermicompost system in their classrooms. The City of Springfield utilizes an integrated system which includes many active, successful programs and services.

The Integrated Solid Waste Management System (ISWMS) consists of these various components:

*__Curbside Recycling__ - Curbside recycling is the easiest, most convenient method of recycling. You simply set the recyclables by your curb on your designated collection day. All licensed waste haulers offer this convenient service.

*__Household Chemical Collection Center__ - Springfield's Household Chemical Collection Center accepts household-generated chemical waste. This facility allows citizens to remain in their vehicles while technicians remove the items from their cars. The average trip through the covered drive-through facility totals five minutes or less.

*__Information and Education__ - This is an ongoing program that offers curriculum guides, presentations, brochures and other information including the Recycling Hotline.

Market Development - Ongoing efforts continue to develop new markets and to expand existing markets for recyclables.

Springfield Sanitary Landfill - Non-recyclable solid waste is taken here and disposal is monitored by sound landfill management.

Yardwaste Recycling Center - Yardwaste is composted and brush is chipped into landscaping mulch at this center. The facility is "one-stop-shopping" for your yard care needs. In just one trip, you can bring your grass clippings, leaves, and limbs and take home compost and wood mulch.

Recycling Centers - There are several convenient sites offered to Greene County residents where you can recycle aluminum, tin/steel cans, milk jugs, two-liter bottles, numbers 1 - 7 plastics, glass containers, cardboard, magazines, newspaper, mixed paper, and other items.

Any one of these programs or services could not stand alone as the answer to the complex challenges facing today's municipal solid waste managers. Yet, when utilized as a part of the Integrated Solid Waste Management System, the combined effect on the reduction of our waste stream is significant. For more information, call the City of Springfield Recycling Hotline at 864-1904 or visit our website at www.springfieldmo.gov/recycling.

The revenues generated from tipping fees at the City's Sanitary Landfill fund Springfield's Integrated Solid Waste Management System.

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WHY BOTHER WITH WORMS?

The idea of keeping worms in the classroom for composting food waste may seem like a science project, but it can be much, much more! Vermicomposting or vermiculture (composting with worms) in a classroom can be applied across nearly all curricula. Exercises using a worm bin and its lively inhabitants touch upon many of the Show-Me Standards for both Performance and Knowledge Standards as well as adapt easily to all learning styles.

Activities utilizing vermiculture in the classroom could serve to strengthen performance within Goal 1 (1.1; 1.2; 1.5; 1.6; 1.8), within Goal 2 (2.1; 2.3; 2.5), within Goal 3 (3.1; 3.5; 3.6), as well as within Goal 4 (4.1; 4.6).

With very few materials and a little bit of imagination, vermiculture in the classroom can enhance knowledge in communication arts (CA1; CA3; CA4; CA6), fine arts (FA1), mathematics (MA1; MA6), social studies (SS7), science (SC2; SC3; SC4; SC7; SC8), and even physical education (HP1; HP4).

From counting to measuring to graphing to drawing to singing to moving like a worm to listening to stories and writing them, worms in the classroom just may end up being something pulled out every day throughout the year – and not just for lunch leftovers *(which is still a very important reason to have them there in the first place).*

GOALS

1. The student will use inquiry to plan and conduct hands-on scientific investigations.

    ⇒ asks questions

    ⇒ makes predictions

    ⇒ observes, describes and classifies objects

    ⇒ employs simple tools and equipment

    ⇒ plans and conducts a simple investigation

    ⇒ gathers and records data accurately

2. The student will investigate matter and energy.

    ⇒ measurement (mass)

    ⇒ matter

3. The student will explore the interaction between organisms and the environment.

    ⇒ interaction between organisms and their environment

    ⇒ habitats

    ⇒ beneficial and harmful effects of humans on the environment

    ⇒ energy flow (food chains, food webs)

    ⇒ life cycles of organisms

4. The student will investigate the earth, its materials and natural processes.

    ⇒ properties of soils

    ⇒ natural resources

5. The student will recognize that science enables people to gain knowledge and create solutions to problems.

WHY SHOULD I COMPOST MY FOOD WASTE?

Worms promote a natural process of decomposition. Their bodies are capable of converting this organic food waste into nutrient-rich compost material simply and naturally. When food waste is thrown into landfills, this resource is wasted.

Therefore, another reason to compost is to reduce the amount of waste that occupies space in landfills. Approximately 7% of our garbage is food waste. When organic material (material coming from living things) is buried in landfills, there is not enough oxygen to allow decomposition to occur. Decomposition is the break down of material into a simpler substance.

Also, grinding food waste in garbage disposals produces organic waste and adds it to the wastewater. This requires more treatment by wastewater plants including additional chemicals, more fuel and the use of more energy and labor. The garbage disposal waste in wastewater also produces more sludge at treatment plants. The sludge must be processed for land application again, using additional energy, fuel, manpower, etc.

Since food waste is so easily and naturally turned into high quality soil, it is a valuable resource.

It was discovered that when landfills were uncovered after 75 years, hotdogs were still not decomposed!

HOW DOES THIS REALLY WORK?

Worms make tunnels in the ground, called burrows that allow rainwater and air to be absorbed and get to plant roots. This soil conditioning decreases the chance that the rainwater will erode the top soil. If the water is flowing into these burrows, less will be washed away. As we know, soil is a very important natural resource because it is the basis for which vegetation and organisms grow and live, which, in turn, feeds humans and animals.

Earthworms take in organic material, pass it through their digestive system and deposit nutrient-rich soil. To help in the digestion of organic material, the earthworm has tiny stones in its gizzard that work to break down what was eaten. The material that leaves the earthworm's body is called castings. Vermicomposting entails more than just castings. Without vermicompost, there are worm castings, but also, some decomposing bedding and organic material.

WHAT ARE THE PHYSICAL CHARACTERISTICS OF A WORM?

Worms have soft bodies and no bones, legs or arms. They are invertebrate. Worms do not have eyes or teeth. Their mouths are very muscular so that food can be easily swallowed. However, without teeth, they must eat food small enough to "suck" into their mouths.

The worms are made of rings and grooves called segments. Each of these segments have bristles called setae that help the worm move. There is a large swollen band around the worm called clitellum. The short end of this band is where the mouth is located (see "How do Worms Reproduce?" for more details on the clitellum.)

WHAT CONDITIONS DO WORMS NEED?

Temperature

It is very important not to let the worms freeze. The vermicomposting project works most efficiently at temperatures between 55-77 degrees F. If temperatures get beyond 84 degrees F, it could also be detrimental to the worms. Therefore, it is important to control the temperature by proper placement of the vermin-bin to keep conditions favorable.

Moisture

Worms require a moist environment. Since worms breathe through their skin, it is important that moisture be present to ensure proper air flow. Worm bodies consist of 75% water. Therefore, we must keep a moist climate in the bin by maintaining about 75% water content in the bedding. When you see a dead worm on a hot sidewalk in the summer, the worm's moisture content has dropped below 75%. However, it is also imperative that you do not water them too much. This could result in flooding and cause the worms to drown. We should remember to keep the

bin moist, not soaked. Ideally, the bin should rarely have to be watered. As the food waste decomposes, adequate moisture is generated naturally. However, if the bin is, for instance, placed in direct sunlight or near a heating register, these natural conditions will be altered. Properly wetted bedding in the vermin-bin should feel like a damp sponge.

Oxygen

Worms breathe in oxygen and produce carbon dioxide. Worms do not have lungs, but breathe through their skin. Proper moisture and oxygen flow is needed so that the worms can breathe. Allowing for the flow of oxygen in the bin is crucial to the success of vermicompost. Oxygen is needed to keep the worms alive so that they can do their job. To assure adequate oxygen flow, proper bedding (loose, fluffy shredded paper) and sufficient ventilation (see "How to Construct a Vermicomposting Bin") are two critical considerations.

Light

Worms do not like bright light. They are light sensitive and prefer dark places. This is why they stay in soil or bedding or under logs, to avoid light.

GETTING TO KNOW YOUR WORMS

ACTIVITY: Before any discussion of the worms, have the students get into groups. Give each group two worms. Have the groups get a damp paper towel and a dry paper towel and lay them side by side. There should be a worm on each towel. Give the students magnifying glasses and have them observe and discuss the following:

1. Which towel do the worms prefer? What does this tell us about the kind of environment they need?

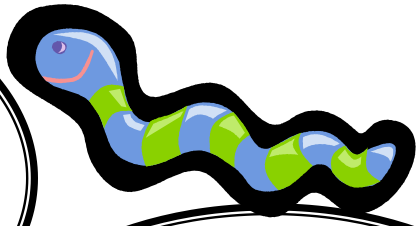
2. Do the worms have a mouth?
   eyes?
   teeth?
   legs?

3. What does the worm's skin feel like?

4. Which end of the worm is the head and which is the tail?

Learning Extension:

Have students create an obstacle for the worms to work through. Students can show their obstacles and tell how their worms reacted.



Learning Extension:

Have the students write a short story, from the worm's point of view, based on what they have observed about the physical characteristics and preferences.

HOW DO WORMS REPRODUCE?

The reproductive system of a worm is very fascinating. Worms are both male and female. This means that they produce both eggs and sperm. If the worm has a large swollen band, this is indicative of a mature worm. This large, swollen area is called the clitellum. The clitellum produces mucus that allows for two worms to join. Once joined, the worms pass sperm from each other to a sperm storage sac. After they detach, a cocoon is formed on the clitellum. The worm then backs out of this hardened cocoon and deposits sperm and eggs into the cocoon to be fertilized. Cocoons look much like a small grain of rice. It is at least three weeks before any of the several babies hatch. Although each cocoon has potential to hatch 20 fertilized eggs, most cocoons only hatch two to three. Worms usually live about a year. However, because of the fast rate in which they reproduce, there is no fear of a limited worm population.

LIGHT OR **DARK**?

ACTIVITY: Have the students get into groups and construct some sort of "tent" (for instance, two small boxes with a piece of paper or cloth draped over the top). Give each group a flashlight and a few worms. The students are to decide if worms like dark areas or lighted areas by shining the flashlight on them and seeing where they go, in the tent or toward the light? Have the students guess (hypothesize) what they think will happen, and then test their hypothesis.

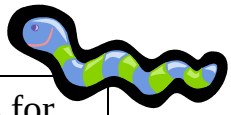
A little more light fun ……

Give each group two different jars each with a different type of soil in them (i.e. sand, potting soil, etc.). Have the students put a few worms in each jar and observe the following:

1. whether they go into the soil or stay on top of the soil.
2. which soil they seem to react in faster.

*This would be a good time to introduce the term **burrowing**. Have students observe if this action takes place in their jars.*

HOW TO CONTRUCT A VERMICOMPOSTING BIN



The vermicomposting project is very versatile. The directions for constructing the bin can be used for a classroom bin or a home bin. The following pages are designed so they can be used as a separate document from this guide. This enables teachers to copy it for any interested parents, colleagues, etc.

When building the bin, there are precautions that should be taken.

1. Wear Safety Goggles

2. Be aware of the drill. Keep hands, arms, etc. away from an active drill.

3. When children are doing the constructing, make sure there is an adult to assist them with the equipment.

Step 1: How to Construct a Vermicomposting Bin

The first step of construction is to select a bin. Hard-type plastic storage containers work well for vermicomposting bins. The minimum dimensions should be 20x15x10. Begin by drilling 3/8-inch holes in the top, bottom and sides of the bin for ventilation and drainage.

Step 2

Number the sides of the bin to designate feeding cells or areas.
This will allow rotation of the feeding areas and tracking of optimum feeding rates.
The bin should have 6-8 feeding cells.

Step 3

Weigh the water. It should equal about six pounds. (note: when measuring, set the scale to 0, weigh the empty container then the container with water and subtract to get the correct water weight).

Step 4

Weigh the shredded paper or bedding. The bedding should equal about 2 pounds. The same measuring technique noted in step number 3 applies when measuring the bedding.

Step 5

Slowly add water to the bedding and mix. It is important to use a watering container that diffuses the water so the bedding does not become soaked or compacted. Mix the water and bedding in a larger container separate from the vermin-bin.

Step 6

Add the bedding with its 75% moisture content to the vermin-bin and fluff. Properly wetted bedding should feel like a damp sponge. Worm movement is restricted in compacted bedding.

WHAT DO I FEED THE WORMS?

A worm's favorite food is coffee grounds. Coffee grounds are small enough that worms can easily eat and digest them. However, any organic waste, such as vegetable waste, can be given to the worms. Leftover plate food or spoiled food such as spaghetti, potatoes, noodles and cottage cheese can also go into the worm bin. (If you have questions on other specific items, you may refer to additional resource materials). Tea and tea bags and coffee still in the filter can be added to the bin. This is because the filters are organic material; they are made from paper. You should *not* put meat or oils in the bin.

For a classroom bin, there are a few precautions:

1. Do not feed the worms citrus fruits. This could cause fruit flies, unwanted pests and offensive odors.

2. For purposes of this project, use only leftover food from the cafeteria serving line. This would be the food that has been prepared but never served. Do not allow food that has come into contact with human hands or mouth to be fed to the worms.

3. Use rubber or nitrile type gloves (no cloth gloves) when feeding the worms or handling the compost.

4. ALWAYS wash hands after feeding the worms or handling the compost.

Burying the food

The vermin-bin has six locations where food waste can be buried. Every time food waste is buried records should be kept (see Classroom Vermicomposting Log Sheets). The food waste should be weighed (see step 2 "How to Feed the Worms"), recorded on the log sheet and buried in a different location than the last feeding. The feeding should run in a sequence and then be repeated. It is wise to observe previous feeding locations in order to decide if more or less food needs to be added. If most of the food is left, portions should be cut back. If the food and bedding is being eaten, the worms are not getting enough food. Ideally, the

bedding should not have to be replaced. The worms eat about half their body weight daily. They should be fed on regular intervals. These intervals should be established based on observations of food eaten and classroom or activity scheduling. Usually worms are fed a minimum of twice weekly.

Responsibility!

If the students are required to feed and care for the worms they learn to appreciate that the worms are living, breathing creatures. The worms must have their needs met in order to survive. Students also become aware of how important worms are to our environment. This is why when worms are brought into the classroom, student responsibility for their well-being is imperative.

HOW TO FEED THE WORMS

Step 1

Feed the worms in cell 1, then the next feeding time in cell 2, and so on. After all cells have been fed, begin again with cell 1.

If there is more food waste than worm castings when cell 1 is opened for the second feeding rotation, decrease feeding rate an ounce or two. Likewise, if all food waste is composted, food may need to be slightly increased. After a few feeding rotations, the optimum feeding rate for that particular bin should be determined.

To feed the worms, dig a 4-inch diameter hole in the bedding to within 3 inches of the bottom. Always pull the bedding up and out. The bedding should stay fluffed at all times. Compacted bedding, even when feeding, restricts worm movement and will decrease vermicomposting efficiency.

Step 2

Weigh the food waste on the scales provided. (Note: set the scales to 0, weigh empty container, then container with food waste and subtract to get the weight of the food). Approximately 8 to 10 oz twice a week should be a sufficient feeding rate for the vermi-bin.

Step 3

After consulting with the log sheet, add food to the appropriate cell.
Cover the cell with the bedding that was removed in step 1.
Fluff the bedding while replacing the feeding cell.

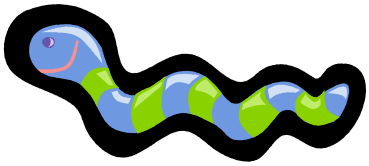
CLASSROOM VERMICOMPOSTING LOG SHEETS

Set up date _____

Initial weight of worms _____

Type of bedding _____

Number of cells in bin _____



Date	Day	Cell #	Ounces food added	Total # oz. to date	Ounces water added	What did you feed the worms?

Date	Day	Cell #	Ounces food added	Total # oz. to date	Ounces water added	What did you feed the worms?

WHEN I'M READY TO EMPTY MY BIN…

When you are ready to discontinue the project, you may want to stop or decrease the amount of food you are feeding the worms about 30 to 40 days before you plan to empty the bin. This will allow the worms to decompose the bedding. The worms and the end product, nutrient-rich compost, can then be used as a fertilizer or amendment for plants, areas around trees, etc. The class can decide the most appropriate placement for the worms and compost by using their knowledge of the worms' habitat preferences and needs. The soil should be well drained and loose when released into the selected area. If no suitable area is available, call the City of Springfield Recycling Hotline at 864-1904 and an appropriate home will be found. You may keep the bin and accessories to be cleaned and prepared for the next group of students.

ADDITIONAL SUGGESTIONS

Mathematics/Science

1. Students gather, measure and record all materials fed to the worms.

2. Students record observed changes in worms, food, content, etc.

3. Students extend their measurement findings by calculating averages of amount fed, weighing amount of enriched soil made, making graphs and charts of observations, calculations, etc.

Language Arts

4. Have students write a poem about worms (requiring them to use facts learned about the worms).

5. Have the students create a story (from a worm's point of view) about life in a worm bin.

Literature Connection

Wonderful Worms by Linda Glaser

Worm's Eye View by Kipchak Johnson

The Magic School Bus Inside the Earth by Joanne Cole

GLOSSARY

Bedding	moisture retaining medium, such as shredded paper, used to house worms
Burrow	a tunnel made in the ground by worms
Clitellum	the swollen region of a worm where the cocoon is formed
Decompose	to break down into a simpler substance
Organic	coming from living organisms
Segment	one of many rings and grooves that make up the worm's body
Setae	bristles on the segments of a worm that aid in worm movement
Vermicomposting	to compost with the help of worms
Worm Castings	material deposited from a worm's anus
Sludge	solids created during treatment of wastewater

SOURCES

Worms Eat My Garbage by Mary Applehof

Break It Down! The Compost Connection by Missouri Department of Natural Resources

City of Springfield

Integrated Solid Waste Management System

Curbside Recycling
(provided by private haulers)
Household Chemical Collection Center
Information and Education Program
Springfield Sanitary Landfill
Market Development
Recycling Centers
Yardwaste Recycling Center

Programs and activities of the Integrated Solid Waste Management System are funded by the tipping fees generated at the Springfield Sanitary Landfill.

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